Healthy feeding habits: efficacy results from a cluster-randomized, controlled exploratory trial of a novel, habit-based intervention with parents[1–3]

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ABSTRACT

Background: As dietary gatekeepers for young children, parents are often the proximal target of family-based dietary interventions. Habit theory offers a novel approach to modifying parental feeding, based on "context-dependent repetition" to promote automatic responding and to reduce decisional conflict.

Objective: This exploratory trial evaluated an intervention promoting habit formation for 3 parental feeding behaviors: serving fruit/vegetables, serving healthy snacks, and serving nonsweetened drinks. The primary outcome was parental habit strength for each behavior. The secondary outcome was children's food intake.

Design: Parents of children aged 2–6 y (n = 126) were recruited from 6 children's centers in London and cluster-randomized to intervention (n = 3) or no-treatment control (n = 3) conditions. Parents in the intervention group (n = 58) received training on habit formation for 3 feeding behaviors; control participants (n = 68) were asked only to complete the measures. At baseline and after treatment, parents completed validated measures of subjective "automaticity" for feeding behaviors and a brief child food-frequency measure. Parents in the intervention group were interviewed about the program. The change between groups, after clustering was controlled for, was analyzed.

Results: For all parental feeding behaviors, automaticity increased more in the intervention group than in the control group ($P < 0.01$ for all). Significant intervention effects on children's intake of vegetables (P = 0.003), healthy snacks (P = 0.009), and water (P = 0.032) were observed. Changes in children's food intake correlated with changes in parental automaticity of feeding behaviors, and program acceptability was high.

Conclusions: A habit-based intervention successfully modified parental feeding behaviors, affected children's diets positively, and was well received by parents. Habit theory provides a promising new tool to support family-based obesity prevention. This trial was registered as ISRCTN09910187. *Am J Clin Nutr* 2013;98:769–77.

INTRODUCTION

Worldwide, children's diets are characterized by overconsumption of energy-dense, nutrient-poor foods and drinks (1–3) and low intakes of fruit and vegetables (1, 4). A poor diet contributes to obesity and other nutrition-related diseases in childhood (5–7), and, because dietary patterns tend to track across the life-course (8–11), it increases the risk of adult disease. Early interventions are therefore needed for long-term health gain.

As the dietary gatekeepers for young children, parents are often the target of early-years interventions. However, whereas some parent interventions have achieved positive dietary changes (12), results have often been disappointing (13–15). One possible explanation is that many interventions draw on knowledge-based models: parents are given nutrition information or taught practical skills (eg, food preparation), which are assumed to translate into better feeding practices (16–18). However, knowledge-based interventions have limited efficacy across many domains of health behavior (19–21) and may also have limitations in the area of parental feeding.

Contemporary analyses of health and social behaviors highlight a range of determinants that fall outside the cognitive domain (22, 23). One that is attracting interest is habit. Habits are behaviors that have, through repetition, become "automatic," ie, they require minimal deliberation or planning and can be enacted without conscious intention (24, 25). Historically, the concept of habit has been invoked predominantly to explain the persistence of unhealthy behaviors (26–28), but more recently it has been applied to positive health behaviors (22, 29–34). The key element of habit acquisition is "context-specific repetition." This involves carrying out the target behavior repeatedly in the same situation to reinforce associations between the behavior and the situational cues. For simple behaviors, this progressively increases the "automaticity" of the behavior (35, 36) until it becomes a habit (34, 37). Once formed, habits self-perpetuate because each encounter with the associated cue reinforces the situation-behavior link (34).

A habit-based approach has been used successfully to increase negative energy balance behaviors in overweight adults, which in turn have resulted in weight loss (31, 32). In the family context, the habit model could be used to help parents develop automatic healthy feeding behaviors, which in turn could influence food intakes in children. We developed an intervention with the use of

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the habit model to help parents adopt 3 healthy feeding habits: offering fruit/vegetables, serving healthy snacks, and serving healthy drinks.

Pilot data from a case series of 10 families who were given the healthy feeding habits intervention and were visited at home 4 times over 8 wk showed that the intervention was well received, was rated as easy to follow, and achieved high levels of habit formation (mean change of 3.3 points on a standard 1–7 scale of subjective automaticity). This article describes the second stage of the evaluation (38): a small-scale randomized controlled trial. The primary aim was to test whether a habit-based intervention could increase the automaticity of parental feeding behaviors, and the secondary aim was to examine the effects on children's food intake.

SUBJECTS AND METHODS

Trial design

A cluster-randomized, parallel-groups design was used for this exploratory trial, which took place between May 2010 and January 2012. Cluster randomization was used to avoid contamination between the treatment and control groups as parents were recruited from Stay and Play sessions at Children's Centers (equivalent of Head Start Centers in America), where parents remain in a group format for the duration of the session alongside their children. The pathway through the trial is illustrated in **Figure 1**. Institutional ethical approval was granted by the University College London Research Ethics Committee.

Sample size

The pilot case series had shown a mean (±SD) change in automaticity of 3.3 ± 1.4 points between baseline and 8 wk on a validated short form of the Self-Report Habit Index (39, 40); however, that study was conducted in a highly motivated group of families that have taken part in research before, and there was no control condition. The current trial was therefore powered to detect a more modest change in automaticity scores (1.3 points) between the intervention and control groups, because the trial population could be more heterogeneous and the control group could also experience a small change as a consequence of taking part in the study (41). On the basis of an average cluster size of 15 and an estimated intracluster correlation of 0.03, a total of 90 participants drawn from 6 clusters were needed (90% power, 2-sided 5% statistical significance). To allow for attrition, we therefore aimed to recruit 20 participants from each cluster.

Recruitment of clusters

Ten Children's Centers located in one borough of London, United Kingdom, were contacted about participating in a research

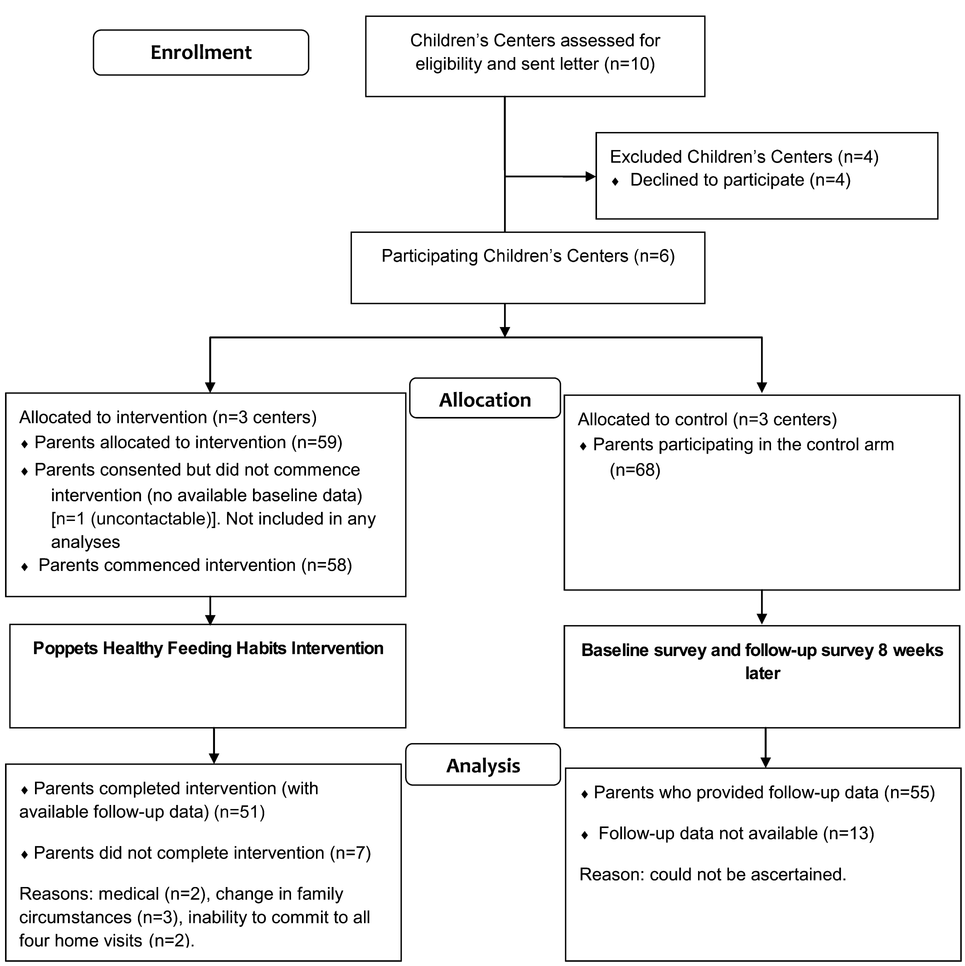

FIGURE 1. Flow diagram of participants throughout the trial and the numbers of parents who provided data.

project examining parental feeding. The centers were eligible if they were not taking part in similar research and offered Stay and Play sessions to parents with children aged between 2 and 6 y. Six centers agreed to take part and were randomly assigned to intervention or no-treatment control conditions (3 centers per arm).

Recruitment of participants

The study was promoted by posters and leaflets placed in the Children's Centers, and researchers also attended Stay and Play sessions. Parents were eligible to participate if they had a child aged between 2 and 6 y of age, with no known medical or psychological condition that interfered with diet, and that spoke sufficient English to understand the study materials. Parents with more than one eligible child were asked to choose one "target" child for the measurement, and they were reminded to think about the target child when completing the measures. Given the drop-in nature of Stay and Play sessions, we do not have details on the exact number of potential participants. Across participating clusters, the number of parent/child dyads allowed in a given Stay and Play session ranged from 8 to 20, and researchers attended between 5 and 10 sessions per center.

Individual consent was sought after randomization. In intervention centers, the study was described as helping parents improve their child's diet and involving 4 home visits. Parents who volunteered to participate were asked to complete a consent form and baseline questionnaire before the first session. In control centers, the study was described as a survey of children's eating habits, and parents were offered information to improve healthy eating in children plus a supermarket voucher on study completion. These parents received an envelope containing an information sheet, a baseline questionnaire, and a Freepost envelope (to mail it back to the research team). The information sheet and questionnaire stated that by completing and returning the questionnaire, parents were giving consent for their information to be used. All participants were advised that they were free to withdraw from the study at any point.

Randomization

A randomization list was generated by using random-number generation in the Statistical Package for the Social Science version 15.0 (SPSS Inc). Randomization at the cluster level was carried out by an independent researcher at the University College London after all clusters had been recruited. After randomization, the allocation was revealed to the researchers carrying out the trial. The researcher then proceeded to recruit participants according to the intervention or control group procedures; they were therefore not able to be blind to the cluster allocation. Because of the nature of the intervention, parents in the intervention arm and researchers delivering the intervention were also not blind. However, because randomization occurred at the cluster level, parents in both groups were unaware of the existence of a comparison group.

Intervention

The healthy feeding habits intervention was delivered by researchers over the course of 4 visits to the family home in an 8-wk period. Researchers received prior training in intervention delivery and followed a written protocol for each visit. Each visit lasted ∼1 h and involved the researcher working through an intervention booklet with the parent. The child was not directly involved. Parents were given a booklet that introduced the concept of habit formation (actions becoming easier with repetition) along with tips for habit formation (eg, having a specific plan, identifying feasible triggers or prompts to habits, sticking to a routine, consistency, persistence). It had detachable self-monitoring sheets to use during the habit acquisition phase. There were sections for each target feeding domain (serving fruit/vegetables, healthy snacks, and healthy drinks). Focusing on one domain at each visit, parents first discussed with the researcher why it is important to have healthy feeding habits for children (eg, adequate fruit and vegetable intake; regular, healthy snack times; and less sugary and/or sweetened drinks). Tips were provided on how best to aid habit formation (eg, planning, establishing a routine, persistence) and practical advice specific to each feeding habit (eg, ways to increase fruit and vegetable intakes, ideas for healthy snacking, ways to promote drinking water or milk). Parents then formulated a specific, healthy feeding goal in that area (eg, to serve water only with the evening meal). Parents also discussed when they would like to start making the changes and briefly identified any barriers and ways to overcome them. At each subsequent visit, parents were encouraged to continue with the previous habit(s) while introducing a new one. The format of each visit was identical except that, in sessions 2, 3, and 4, there was a brief discussion of progress with the current feeding habit(s) before moving on to the next habit.

Measurement of outcomes

Questionnaire measures were completed at baseline and follow-up by all parents. Follow-up measures were completed at the final home visit (after the intervention) for parents in the intervention group, while parents in the control group were mailed the questionnaire after the same approximate time interval (8 wk) with a Freepost return envelope to the researchers. Parents in the intervention group were also asked about their intervention experience during a brief interview at the end of the final visit.

Demographic characteristics

At baseline, parents reported their age and relation to the child, and the child's age, sex, and ethnicity. Ethnicity was categorized as "white" or "other" for statistical analyses because of the small numbers in ethnic minority subgroups. Parental education was reported on a 6-point scale from "no qualifications" to "postgraduate," which was categorized into "compulsory schooling or below" (equivalent to education up to 16 y), "vocational/A/AS-levels" (equivalent to education up to 17–18 y), or "degree level or higher" for those attending university, for the purposes of analysis.

Primary outcome

Our primary outcome was parental habit strength at 8 wk in the intervention group compared with the control group (individual level outcome). This was assessed by using a 4-item version of the Self-Report Habit Index (39, 40), which quantifies the automaticity of simple behaviors. This measure has consistently been shown to have high internal reliability, convergent validity with objective response time–based habit indexes, and sensitivity to theorized effects of habit on action (40, 42). For each feeding behavior, 4 items followed a stem (eg, "Giving my child only water or milk to drink each day is something: I do automatically, I do without having to consciously remember, I do without thinking, I start doing before I realize I'm doing it) with 7-point response scales from "strongly disagree" to "strongly agree." The average score for the 4 items indexed the automaticity of each feeding behavior.

Secondary outcome

Our secondary outcome was child intake of targeted foods at 8 wk in the intervention group compared with control subjects (individual-level outcome). This was assessed with parent-completed questions (43–45). The child's intake of fruit and vegetables was assessed with the following question: "How many servings of fruit [vegetables] does your child typically eat." Parents were asked to include consumption at mealtimes and snacks, and a guide to portion sizes was included. Responses were on a 7-point scale ("less than one per day" to "5 per day") and were scored to reflect the average number of daily servings indicated by each response option as in earlier studies (43–45). Snacks were assessed with "How often does your child have the following as a snack between meals": fruit, vegetables, sweets (eg, chocolate, fruit sweets), sweet snacks (eg, biscuits, cakes, ice cream), savory snacks (eg, crisps, sausage rolls), other savory snacks (eg, oatcakes, rice cakes, breadsticks), dairy snacks (eg, yogurt, fromage frais), and other dairy snacks (eg, cheese) (7-point response scale from "never/rarely" to "3 or more times per day"). Drinks were assessed with "How often does your child have the following drinks, either with or between meals": sweetened carbonated drinks; diet, sweetened, carbonated drinks; other sweetened drinks (eg, squash, fruit drinks); and water, with the same response options as for snacking. Responses were scored to reflect the average number of occasions of consumption a day for healthy and unhealthy snacks and drinks.

Statistical analysis

Data were analyzed by using SPSS version 15.0 (SPSS Inc), both using cases with valid data before and after intervention (completer analysis) and an intention-to-treat analysis using baseline observation carried forward, where postintervention data were missing. A general linear model for complex samples was used to examine after-treatment, between-group differences, controlling for baseline levels of each variable and the child's age and sex and taking clustering into account. Separate models were run for automaticity scores for each feeding behavior and the key child dietary variables. Residuals were examined for all outcomes and approximated normal distribution in most cases. For one variable (child unhealthy snacks), there was one outlier; however, because the results were not sensitive to its inclusion or exclusion, we used the full sample. Within-group changes were examined by using paired *t* tests or Wilcoxon's signed-rank tests as appropriate. To estimate whether changes in parental feeding habits were likely to be responsible for the changes in children's food intake, we calculated correlations (*r*) between changes in parental automaticity for each feeding behavior and changes in the respective child food intake variable within each group.

RESULTS

Most of the participants who engaged with the study completed it. Of the 58 intervention parents who received at least one home visit, 51 completed the program, ie, received all 4 home visits (88%). Most of the intervention parents chose to begin forming habits for fruit and vegetables (n = 27, 47%). Healthy snacks was the most commonly chosen habit at visit 2 (n = 30, 54%), and healthy drinks most commonly selected at visit 3 (n = 29, 54%). Of the 68 control parents, 55 provided follow-up data 8 wk later (81% retention). Reasons for dropout in the intervention arm (n = 7) were cited as medical (n = 2), change in family circumstances (n = 3), and inability to commit to all 4 home visits (n = 2). For the 13 control subjects who withdrew, we were not able to ascertain the reason for not completing the second questionnaire because we did not have ethical approval to follow up in this way. Those who dropped out were not significantly different at baseline in any demographic characteristics or primary or secondary outcomes from those who completed the study. The completer's analysis is presented throughout, but the pattern and significance of results did not differ when the intention-to-treat analysis was used.

Most of the participants were biological mothers (91%), 5% were fathers, and 4% were step/adoptive parents (**Table 1**). Approximately half of the parents (54%) had college-level education, and the average age was 35 y. One-third of the parents owned their home. The children's average age was 3 y, with equal numbers of boys and girls. Just more than one-half of the children (61%) were described as white, 11% as black, 6% as Asian (Indian and Pakistani), and 22% as other. Baseline characteristics for the 2 groups at the individual level are presented in **Table 2** , and cluster-level baseline characteristics are presented in **Table 3** and **Table 4**. Child fruit intake and parent automaticity for healthy snacks appeared slightly higher in the control group than in the treatment group, and parent automaticity for milk/water appeared slightly lower in the control group, at baseline. Apart from this, the groups did not appear to differ at baseline (46).

At follow-up, automaticity scores were significantly different between the groups after baseline scores for all 3 feeding behaviors were controlled for. Intervention parents had higher scores than control parents for giving the child 5 fruit and vegetables a day (the minimum recommended amount in the United Kingdom) (Wald's $F = 16.37$, $P < 0.01$), serving healthy snacks (Wald's $F = 98.19$; $P < 0.001$), and giving healthy drinks (Wald's $F = 150.04$, $P < 0.001$) (**Figure 2**). In the intervention group, automaticity scores from before to after the intervention increased by an average of 1.0 point on the 7-point scale for the fruit and vegetable feeding habit ($P < 0.001$), 1.8 points for the healthy snacks feeding habit ($P < 0.001$), and 1.4 points for the health drinks feeding habit ($P < 0.001$). No significant changes in automaticity were observed in the control group (**Table 5**).

Controlling for baseline levels, significant postintervention differences in children's vegetable intake (Wald's $F = 28.45$, $P < 0.01$), healthy snack intake (Wald's $F = 17.11$, $P < 0.01$), and water intake (Wald's $F = 8.67$, $P < 0.05$) were found, with children in the intervention group consuming greater amounts.

TABLE 1
Baseline characteristics of participants in the intervention and control groups (individual level)[1]

Characteristic	Whole sample (n = 126)	Intervention group (n = 58)	Control group (n = 68)
Sex of child, male [n (%)]	63 (50)	29 (50)	34 (50)
Child's age (y)	3.2 ± 1.1[2] [121]	3.4 ± 1.2	3.0 ± 0.9
Ethnicity [n (%)]			
White	75 (61) [123]	32 (57.1)	43 (64.2)
Other	48 (39) [123]	24 (42.9)	24 (35.8)
Age of respondent (y)	35.3 ± 6.9 [105]	35.7 ± 7.7	34.9 ± 6.1
Relation to child [n (%)]			
Mother, biological	115 (91.3)	53 (91.4)	62 (91.2)
Father, biological	6 (4.8)	4 (6.9)	2 (2.9)
Other	5 (4)	1 (1.7)	4 (5.8)
Age of respondent who left full-time education (y)	20.9 ± 4.5 [94]	21.1 ± 5.1	20.7 ± 4.1
Respondent qualification [n (%)]			
Compulsory schooling or below[3]	25 (20.7) [121]	11 (20.4)	14 (20.9)
Vocational/A/AS levels[4]	31 (25.6) [121]	15 (27.8)	16 (23.9)
Degree level or higher	65 (53.7) [121]	28 (51.9)	37 (55.2)
Living status [n (%)]			
Homeowner	42 (33.9) [124]	18 (31.6)	24 (35.8)
Other	82 (66.1) [124]	39 (68.4)	43 (64.2)

[1] n values are in brackets. The groups were not compared statistically, in line with Consolidated Standards of Reporting Trials guidelines (46).
[2] Mean ± SD (all such values).
[3] Equivalent to education up to 16 y.
[4] Equivalent to education up to 17–18 y.

Group differences were not significant for fruit, unhealthy snacks, and sweet drinks; although the effects were in the predicted direction (**Figure 3**). Children in the intervention group increased their fruit intake by an average of 0.5 servings/d ($P < 0.001$) and vegetable intake by 0.8 servings/d ($P < 0.001$). Unhealthy snack intake decreased by 0.4 occasions/d ($P < 0.01$), and healthy snacking increased by 1.0 occasion/d ($P < 0.01$). Children in the intervention group also reduced the number of daily occasions of consuming sweet drinks by 0.6 ($P < 0.001$) and increased their water intake by 0.6 occasions/d ($P < 0.001$). No significant changes in food/drink intake were found in the control group (Table 5).

In the intervention group, increased parental automaticity for serving fruit/vegetables was associated with increased fruit and vegetable consumption in the children ($r = 0.52$, $P < 0.001$), and increased automaticity for serving healthy drinks was associated with the child having more drinks of water ($r = 0.54$, $P < 0.001$) and fewer sweet drinks ($r = -0.38$, $P < 0.01$). Increased automaticity for serving healthy snacks was associated with the child having fewer snacks each day ($r = -0.40$, $P < 0.05$), but not with intake of healthy or unhealthy types of snack. For the control group, no significant correlations were found between change in automaticity for the feeding behaviors and the respective child dietary variables, except for increased automaticity for serving healthy drinks being correlated with reduced child intake of sweet drinks ($r = -0.319$, $P < 0.05$).

Acceptability of the program in the intervention group was assessed in a brief post-intervention interview with the researcher on the last home visit. Parents reported that the program was easy to understand and to integrate into daily life: "It was pretty easy,

TABLE 2
Baseline values for primary and secondary outcomes in the intervention and control groups (individual level)[1]

Outcome	Whole sample (n = 126)	Intervention group (n = 58)	Control group (n = 68)
Child			
Fruit intake (servings/d)	2.5 ± 1.2 [126]	2.3 ± 1.3	2.7 ± 1.1
Vegetable intake (servings/d)	1.8 ± 1.1 [126]	1.7 ± 1.4	1.9 ± 0.9
Unhealthy snack intake (occasions/d)	1.2 ± 1.3 [118]	1.3 ± 1.5	1.1 ± 1.1
Healthy snack intake (occasions/d)	2.0 ± 1.4 [118]	2.0 ± 1.5	1.9 ± 1.3
Sweetened drink intake (occasions/d)	1.0 ± 1.2 [116]	1.1 ± 1.3	0.9 ± 1.1
Water intake (occasions/d)	2.2 ± 1.0 [124]	2.1 ± 1.1	2.2 ± 1.0
Parent			
Automaticity score: 5-a-day FV	4.6 ± 1.8 [122]	4.6 ± 2.0	4.7 ± 1.7
Automaticity score: healthy snacks, set times	4.3 ± 1.8 [121]	4.1 ± 2.0	4.5 ± 1.5
Automaticity score: milk/water to drink	4.6 ± 2.0 [122]	4.9 ± 2.1	4.3 ± 1.9

[1] All values are means ± SDs; n values are in brackets. The groups were not compared statistically, in line with Consolidated Standards of Reporting Trials guidelines (46). FV, fruit and vegetables.

TABLE 3
Baseline characteristics of the participants (cluster level)[1]

Characteristic	Children's Center 1	Children's Center 2	Children's Center 3	Children's Center 4	Children's Center 5	Children's Center 6
Sex of child, male [*n* (%)]	8 (38.1)	12 (57.1)	9 (56.3)	8 (47.4)	8 (47.1)	17 (53.1)
Child's age (y)	3.3 ± 1.2[2] [121]	3.5 ± 1.2	3.2 ± 1.1	3.2 ± 0.9	3.0 ± 0.8	2.9 ± 1.0
Ethnicity [*n* (%)]						
White	14 (70.0) [123]	11 (52.4)	7 (46.7)	12 (66.7)	9 (52.9)	22 (68.8)
Other	6 (30.0) [123]	10 (47.6)	8 (53.3)	6 (33.3)	8 (47.1)	10 (31.1)
Age of respondent (y)	36.8 ± 7.7 [105]	32.8 ± 6.1	36.3 ± 8.9	34.6 ± 5.8	32.9 ± 5.8	35.9 ± 6.4
Relation to child [*n* (%)]						
Mother, biological	19 (90.5)	20 (95.2)	14 (87.5)	18 (94.7)	15 (88.2)	29 (90.6)
Father, biological	2 (9.5)	1 (4.8)	1 (6.3)	1 (5.3)	2 (11.8)	1 (3.1)
Other	—	—	1 (6.3)	—	—	2 (6.3)
Age of respondent who left full-time education (y)	20.3 ± 4.8 [94]	22.9 ± 6.6	20.1 ± 2.7	20.1 ± 4.7	17.6 ± 1.7	22.4 ± 3.6
Respondent qualification [*n* (%)]						
Compulsory schooling or below[3]	6 (31.6) [121]	4 (19.0)	1 (7.1)	4 (21.1)	6 (37.5)	4 (12.5)
Vocational/A/AS-levels[4]	4 (21.1) [121]	7 (33.3)	4 (28.6)	6 (31.6)	4 (25.0)	6 (18.8)
Degree level or higher	9 (47.4) [121]	10 (47.6)	9 (64.3)	9 (47.4)	6 (37.5)	22 (68.8)
Living status [*n* (%)]						
Homeowner	6 (28.6) [124]	8 (38.1)	4 (26.7)	6 (31.6)	1 (6.3)	17 (53.1)
Other	15 (71.4) [124]	13 (61.9)	11 (73.3)	13 (68.4)	15 (93.8)	15 (46.9)

[1] *n* values are in brackets. The groups were not compared statistically, in line with Consolidated Standards of Reporting Trials guidelines (46). Centers 1–3: intervention arm; centers 4–6: control arm.
[2] Mean ± SD (all such values).
[3] Equivalent to education up to 16 y.
[4] Equivalent to education up to 17–18 y.

and I could see the benefit of doing these things [healthy habits] straight away"; "Now that we have got to this point we definitely won't be back-tracking." Overall, responses were consistently positive.

DISCUSSION

The habit model has attracted considerable interest in the psychological literature, but we are only aware of one dietary intervention based on habit-formation principles (32) and none that focus on parental habit formation as a route to improving children's diets. The results of this exploratory trial were extremely positive. Parents found the intervention simple and enjoyable, and the targeted parental feeding behaviors became substantially more habitual as indexed by significantly higher scores on a brief validated self-report measure of automaticity (39, 40, 42). As predicted, the parent-focused intervention was associated with positive effects on the child's diet, with increases in vegetable intake, consumption of healthy foods as snacks, and water as a drink. The finding of significant correlations between change in the parental automaticity scores and change in the child's food intake in the intervention group (but not in the control group) was consistent with the idea that increased automaticity of healthy parental feeding behaviors was the route to the changes in the child's food intake. The only outcome for which the association was not significant in the intervention

TABLE 4
Baseline values for primary and secondary outcomes (cluster level)[1]

Outcome	Children's Center 1	Children's Center 2	Children's Center 3	Children's Center 4	Children's Center 5	Children's Center 6
Child						
Fruit intake (servings/d)	1.9 ± 1.2 [126]	2.4 ± 1.2	2.6 ± 1.3	2.7 ± 0.9	2.8 ± 1.3	2.7 ± 1.3
Vegetable intake (servings/d)	1.4 ± 1.2 [126]	1.7 ± 1.2	2.3 ± 1.6	1.8 ± 0.8	1.8 ± 1.0	2.1 ± 0.9
Unhealthy snack intake (occasions/d)	1.5 ± 1.4 [118]	1.6 ± 1.9	0.7 ± 0.6	1.4 ± 1.5	1.3 ± 0.9	0.9 ± 0.8
Healthy snack intake (occasions/d)	3.4 ± 2.6 [118]	3.6 ± 1.7	3.7 ± 2.5	4.7 ± 1.8	4.6 ± 2.0	3.4 ± 1.9
Sweetened drink intake (occasions/d)	1.1 ± 1.4 [116]	1.3 ± 1.3	0.9 ± 1.1	1.3 ± 1.1	1.3 ± 1.1	0.5 ± 0.9
Water intake (occasions/d)	2.1 ± 1.1 [124]	2.0 ± 1.1	2.1 ± 1.0	2.0 ± 1.1	2.0 ± 1.2	2.5 ± 0.8
Parent						
Automaticity score: 5-a-day FV	4.1 ± 2.0 [122]	4.7 ± 1.9	5.1 ± 2.1	4.7 ± 1.3	4.4 ± 1.6	4.8 ± 1.9
Automaticity score: healthy snacks, set times	3.7 ± 2.2 [121]	4.2 ± 1.8	4.5 ± 1.9	4.5 ± 1.5	4.0 ± 1.3	4.8 ± 1.6
Automaticity score: water/milk to drink	4.9 ± 2.2 [122]	4.8 ± 1.9	4.8 ± 2.2	4.8 ± 1.5	3.6 ± 1.9	4.4 ± 2.1

[1] All values are means ± SDs; *n* values in brackets. The groups were not compared statistically, in line with Consolidated Standards of Reporting Trials guidelines (46). Centers 1–3: intervention arm; centers 4–6: control arm. FV, fruit and vegetables.

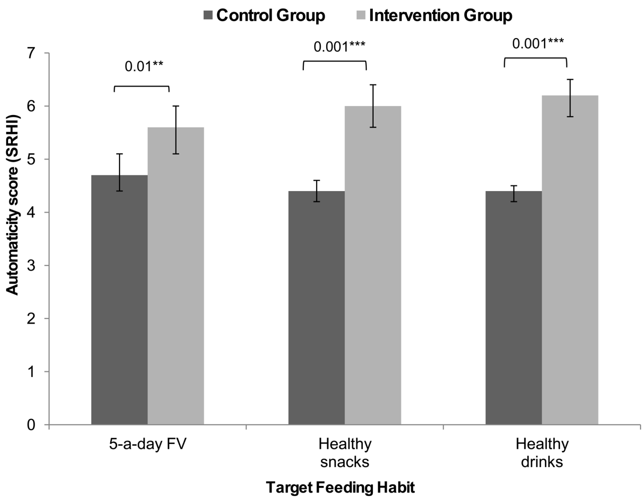

FIGURE 2. Adjusted postintervention mean (±SD) parental automaticity scores for the 3 targeted feeding behaviors in the control and intervention groups. Automaticity scores were measured by using a validated 4-item version of the SRHI. A general linear model for complex samples was used to examine posttreatment, between-group differences. The postintervention means were adjusted for the children's age (in mo) and the respective baseline level. Bars indicate CIs. The completer's analysis is presented; the intention-to-treat analysis showed the same pattern. $**P < 0.01$, $***P < 0.001$. FV, fruit and vegetables; SRHI, Self-Report Habit Index.

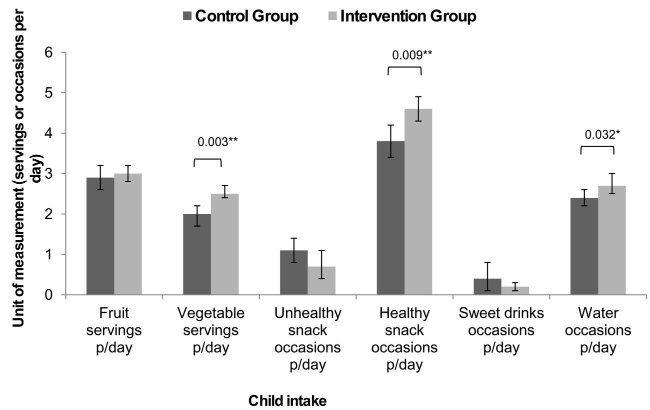

FIGURE 3. Adjusted postintervention mean (±SD) food intakes of children in the control and intervention groups. A general linear model for complex samples was used to examine posttreatment, between-group differences. The postintervention means were adjusted for the children's age (in mo) and respective baseline level. Asterisks indicate level of significance. Bars indicate CIs. The completer's analysis is presented; the intention-to-treat analysis showed the same pattern.

group was for healthy snacks, although the pattern was in the predicted direction.

A habit-based intervention could be used as a supplement to interventions that take a more educational approach. For example, the Nutrition Education Aimed at Toddlers intervention involved 4 group-based nutrition education sessions and 18 home visits with reinforcing activities (47); however, despite this intense intervention activity, positive effects were only seen on parental nutrition knowledge and not on any parent-feeding behaviors or child food intake. The authors of Nutrition Education Aimed at Toddlers recommended that future research should incorporate behavior change techniques to achieve a shift in child dietary quality (47).

TABLE 5
Within-group change scores over the intervention period (before to after the intervention)[1]

	Within-group mean change score	
Outcome variable	Intervention group (n = 51)	Control group (n = 55)
Parental automaticity		
Feeding 5-a-day FV[2]	+1.0 ± 1.4***	+0.1 ± 1.9
Serving healthy snacks	+1.8 ± 2.0***	0.0 ± 1.6
Giving healthy drinks	+1.4 ± 2.1***	+0.1 ± 2.1
Child intake		
Servings of fruit per day	+0.5 ± 1.1***	+0.2 ± 1.0
Servings of vegetables per day	+0.8 ± 1.3***	+0.1 ± 0.8
Unhealthy snack occasions per day	−0.4 ± 0.8**	0.0 ± 0.9
Healthy snack occasions per day	+1.0 ± 2.1**	−0.2 ± 2.1
Sweetened drinks occasions per day	−0.6 ± 0.9***	−0.3 ± 1.0
Water occasions per day	+0.6 ± 1.0***	+0.1 ± 0.9

[1] All values are means ± SDs. $**P < 0.01$, $***P < 0.001$ (paired t tests or Wilcoxon's signed-rank tests).
[2] FV, fruit and vegetables.

The essence of habit formation lies in repeating a behavior in a consistent context so that it becomes an automatic response to that context (48). The increased automaticity experienced by parents in the intervention group suggested that the feeding behaviors were performed with progressively lower cognitive effort and greater behavioral efficiency. A recent systematic review reported that periodic prompts help sustain health behavior change (49), and it would be interesting to investigate whether they would still be necessary when behavior changes are achieved by using the habit model (22). Previous research indicates that the effect of reminders diminishes over time as habits are formed (50).

The time it takes to develop a habit is rarely addressed in the literature, although one study in adults found a range from 18 to 254 d (average: 66 d) to peak automaticity for a variety of diet and exercise behaviors (36). Nonetheless, the same study showed that automaticity developed asymptotically, with initial repetitions causing the greatest gains in habit strength and further repetitions having less of an effect as automaticity plateaued (36). The number of repetitions used in the current intervention (eg, 14–56 d) would be expected to be sufficient to strengthen habits although habit strength may not have peaked. Future research should address longer-term effects, ie, whether automaticity decays over time and whether this affects the improvements in the quality of children's diets.

The strengths of this study include the innovative, theory-based intervention, inclusion of process as well as outcome variables, and assessment of acceptability. The study was able to recruit and retain most of the participants, and the effects were very similar in analyses of completers and intention-to-treat analyses. The drop-in nature of the Children's Centers meant that it was not possible to clearly define the number of potential participants, but the benefit of this context was that it allowed us to recruit individuals from an ethnically and socially diverse population, which increased the generalizability of our findings. Children's Centers across the United Kingdom are situated in areas with higher than average levels of social and economic deprivation, with the aim of improving outcomes for young children and their families from disadvantaged backgrounds. Despite our sample being relatively highly educated, they were more likely to reside in social housing compared with the average for England (~50% compared with 17%, respectively) (51).

An important limitation of this exploratory trial was that all data were based on parent-report. Although this is not unusual for community-based research (29), it means that the results are subject to concerns over social desirability, reliability, and validity. This is equally true of the data from the brief parent-reported food-frequency measure used to gauge child food intake in the current study. Although previous research has shown the value of food-frequency measures in clarifying dietary patterns (45, 52), more validation work on parent-reported child food frequency measures is needed, particularly as it became apparent during the course of the trial that intervention parents regularly misinterpreted the "milk" item within the food-frequency measure. Some parents who indicated that their child drank milk regularly were referring to sweetened milk, ie, plain milk to which flavored sugar powder was added (something that was not considered a healthy drink in this habit-formation context). Given this finding, we focused the secondary outcomes on the 2 categories of *1*) sugary/sweetened drinks and *2*) water. Responder bias may have affected post-intervention questionnaire responses or end-of-intervention interviews because the researcher who delivered the intervention was present in most cases. In addition, the control group received no face-to-face contact with the researchers after being initially approached to take part in the survey research. This means that the results found for the intervention group are confounded by potential effects of face-to-face contact during home visits that the control group did not receive. Some selection bias may also have occurred because randomization was at the cluster level, and the method of individual recruitment after randomization differed between the 2 arms of the study. However, strategies were used to minimize this risk; all centers were identified and recruited before randomization, allocation was concealed from the person who provided access to the cluster, all participants within a cluster were eligible if they met the predefined criteria, and participants were not aware of their allocation to a trial arm.

Overall, these positive results support the conclusion of a systematic review that indicated that parents are receptive to, and capable of, behavior changes to promote a healthy diet and weight in their young children (53). Future research should evaluate the effectiveness of the program when delivered by community staff rather than researchers and examine longer-term outcomes by using objective measures of children's food intake. Overall, the results of this trial show the efficacy of a simple, theoretically underpinned, habit-based intervention for changing parental feeding behaviors and improving the dietary quality of preschool-aged children.

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